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(54) Reinforcement of curved beams

(57) A beam of sheet material (e.g. an automobile front sub-frame member) has a curved section in its axial direction. A support member 40 made of a high modulus of elasticity material is disposed within the beam cross-section so that it extends through the curved section. Faces P of the beam at the curve are held apart by the member 40 when the beam is under load thereby increasing the load carrying capabilities of the beam by reducing or eliminating the tendency of the curved section to deform. Member 40, which is preferably made of metal or synthetic plastics material, has superficial grooves 41 to permit passage of internal protective fluids down the beam, and axially extending bores 42 and shaped lateral sides 43 for reduced weight.

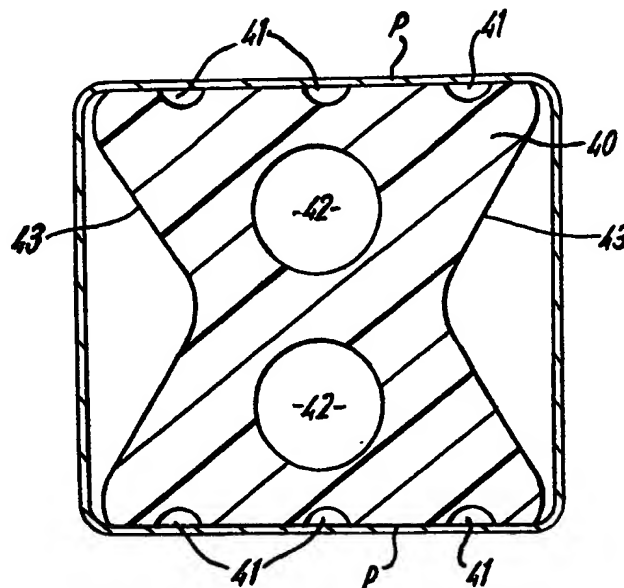
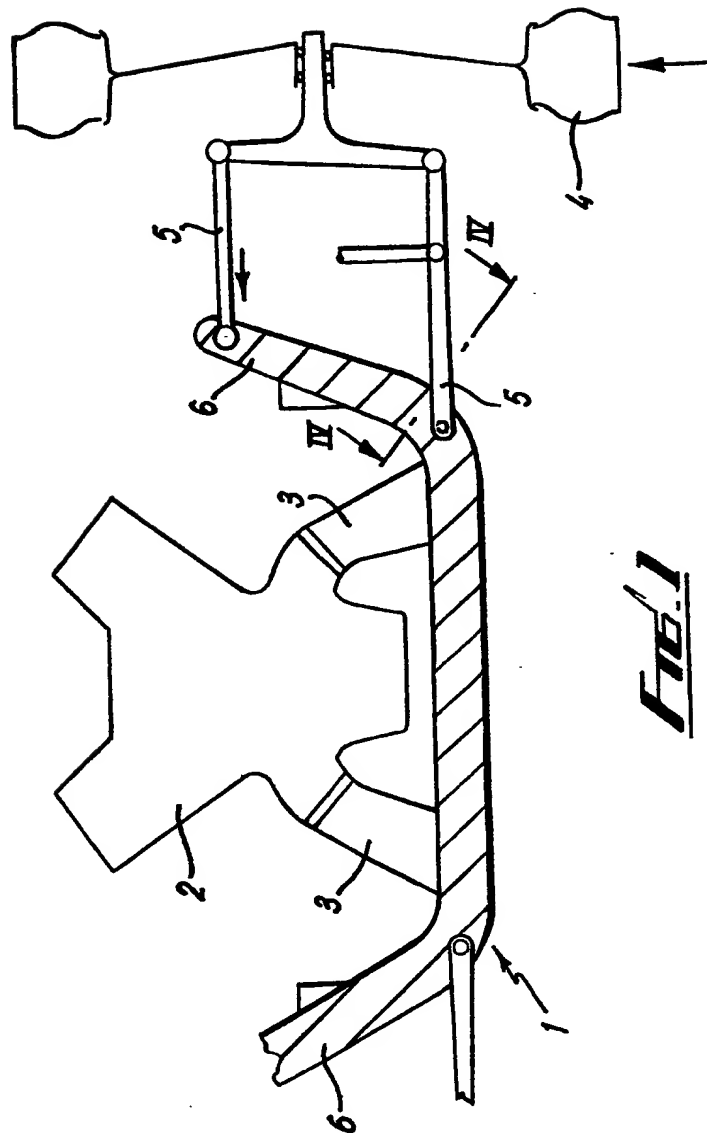


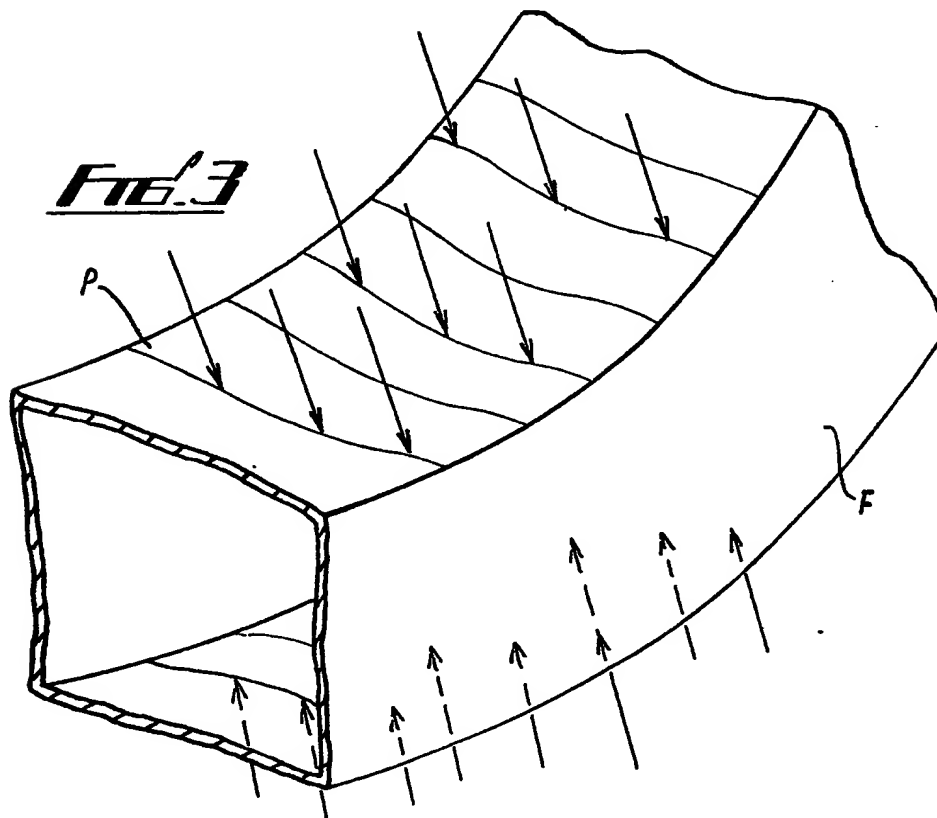
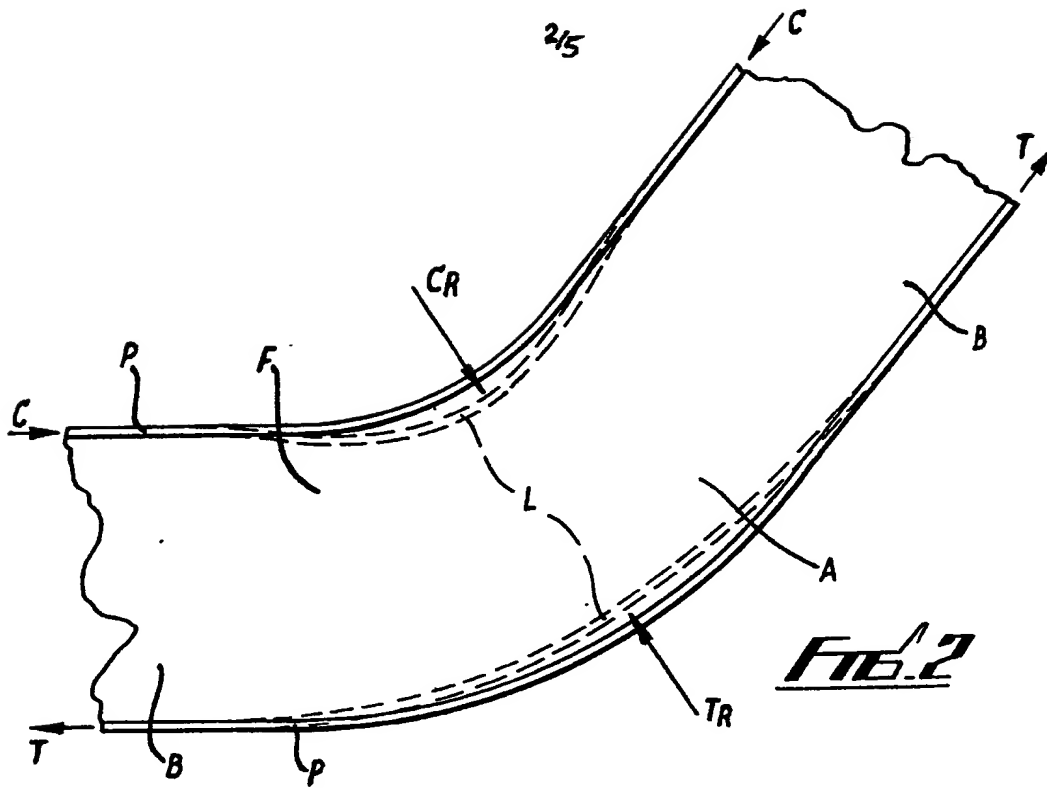
Fig. 4

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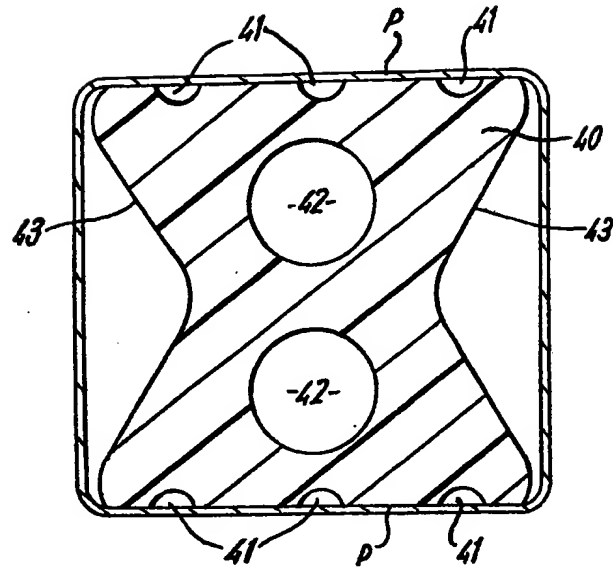


FIG. 4

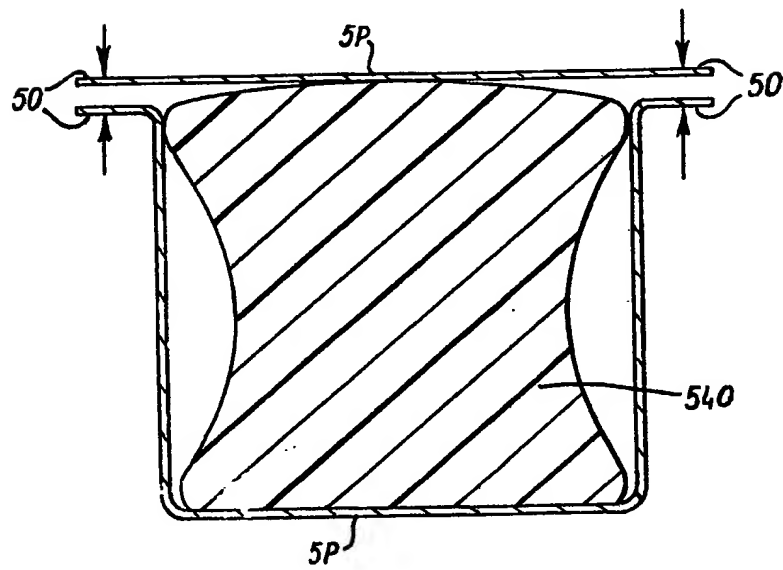


FIG. 5

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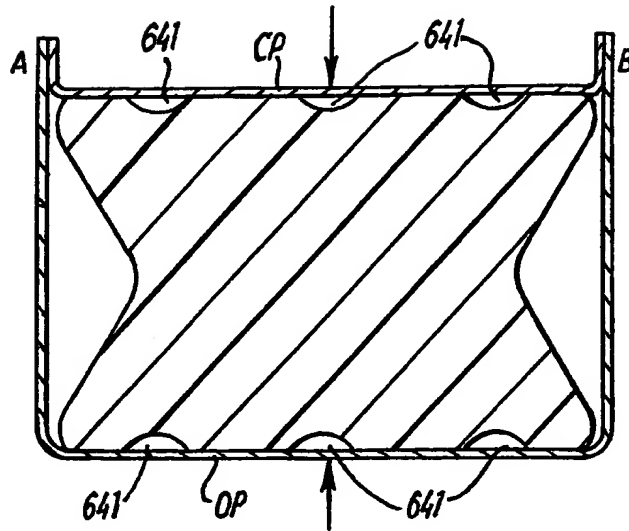


FIG. 6

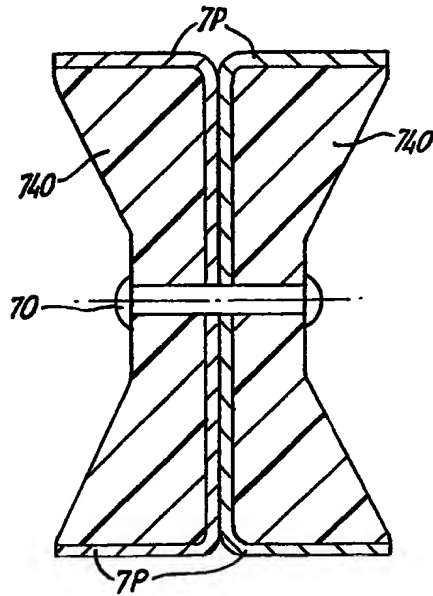
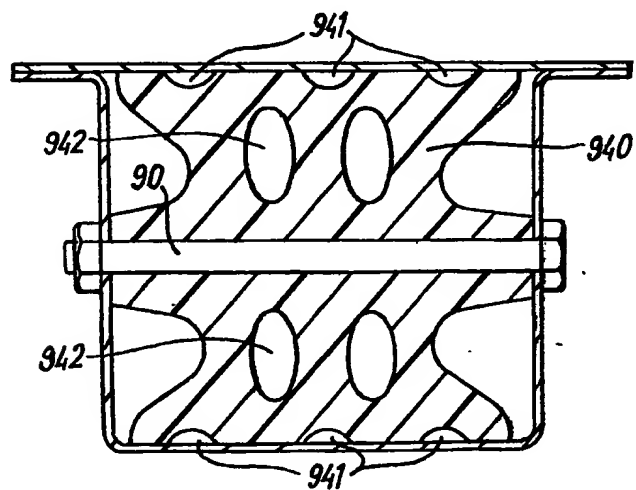
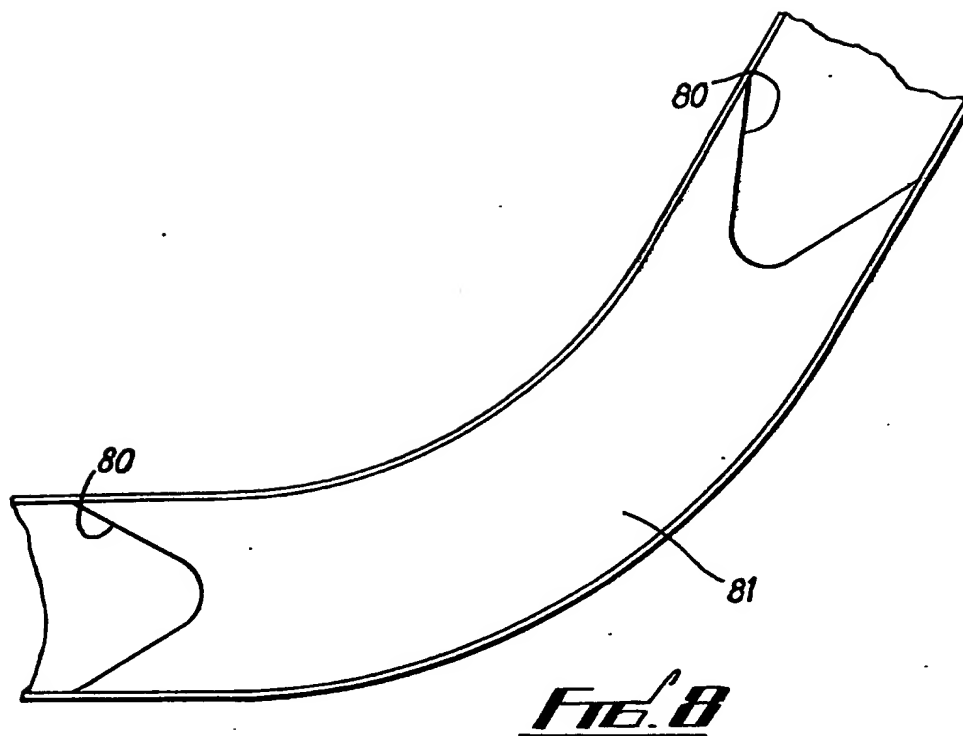


FIG. 7

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SPECIFICATION

Reinforcement of curved beams

5 The present invention relates to beams.

When a beam is built up of sheet material which is sufficiently thin in relation to its width to be readily deflected out of its own plane, there is a considerable loss of efficiency of the cross section at bends in the beam in the plane of the bending moment. This is because the end loads in the plates forming the surfaces furthest from the neutral axis on each side of the bend have a resultant force acting over the length of the bend in a direction which bends the plate out of its own plane. The directions are always such that a plate in a state of compression is deflected so that it adopts a longer path than its desired deflection condition and vice-versa for a plate under tension. This means that the strain in the plate is less than is implied by the deflection of the beam.

The plates in the plane of the bending moment, that is the shear webs, have no means of evading the strain with the result that they control the deflection of the beam, and end load is shed from the flanges to them, increasing their stress and thus reducing the load carrying capacity of the beam as compared with a straight version of a beam having the same cross section.

One way of overcoming these difficulties is by increasing the amount of material in the bend by increasing the thickness of the plate used at that point. This is, however, difficult and expensive to achieve. An alternative is simply to increase the thickness of the plate material throughout the whole beam. This solution, whilst being simpler to achieve, is expensive in material and results in a beam of much greater weight. This in itself renders the solution unacceptable for automobile applications, where the trend is for structural members of reduced weight to reduce vehicle weight and, ultimately, fuel consumption. It is also known to connect opposing load bearing faces of hollow beams together to oppose bending, but again such solutions are difficult and expensive to achieve particularly where, as is often the case, the connection is by a cross member welded to the faces.

According to the present invention there is provided a beam made of sheet material and having a curved portion bounded by surfaces which in use of the beam are load bearing and a support member disposed in the beam at the curved portion but not connected to it along the load bearing surfaces and having a high modulus of elasticity to resist bending of the load bearing surfaces out of the plane of those surfaces when subjected to loads tending to tighten the curvature of the curved portion.

A preferred embodiment of the invention may comprise any one or more of the following preferred features:—

(a) The support member is moulded from synthetic plastics material, for example, polypropylene,

(b) The support member is made from metal, for example, aluminium,

65 (c) The synthetic plastics material of (a) is fibre reinforced,

(d) The support member is provided with superficial grooves to allow passage of fluid material between it and the internal surfaces of the plate material,

70 (e) The support member is relieved to reduce its weight,

(f) The unstressed dimension of the support member in the direction in which, in operation, it is placed under strain is greater than the corresponding dimension of the beam so that the member is under light strain under no load conditions of the beam,

(g) The beam is of closed cross-section,

80 (h) The beam is of open cross-section,

(i) The curved portion is bounded in the axial direction of the beam by straight portions, or portions of a substantially different radius of curvature,

(j) The support member extends into the straight portions or substantially differently curved portions of (i).

In order that the invention may be more clearly understood, one embodiment thereof will now be described, by way of example, with reference to the accompanying drawings in which:—

Fig. 1 diagrammatically shows a box section beam in use in an automobile,

Fig. 2 shows a force diagram for a part of the beam of Fig. 1,

95 Fig. 3 shows a further force diagram,

Fig. 4 shows a cross section through the beam of Fig. 1 along the line IV-IV,

Fig. 5 shows an alternative to the cross section of Fig. 4,

100 Figs. 6, 7 and 9 show a further alternative cross-section to the cross-section of Figs. 4 and 5, and

Fig. 8 shows a section along the axis of the beam portion of Fig. 2.

Referring to Fig. 1, a front sub-frame member, indicated generally by the reference numeral 1, is shown for an automobile. The frame member 1 supports the engine block represented diagrammatically at 2, through support mounts 3 and is connected to the vehicle front wheels 4 (one only shown) via the suspension represented very diagrammatically at 5. During normal operation of the automobile the front wheels 4 of the automobile apply turning couples to arms 6 of the member 1. These result in compressive and tensile forces C and T along the faces of the member 1 (see Fig. 2) which in turn have components with resultant forces C_R and T_R acting in the direction of the associated arrows. These resultant forces act to compress the member 1 at the curves so that the member would adopt the shape shown by the dashed lines L if steps to prevent this were not taken. This deformation of the beam at the curve results in the shedding of the end load from the flanges on side plates F of the beam to the plates P of the beam in the plane of the bending moment which

increases their stress and reduces the load carrying capacity of the beam as compared with a straight version of the beam having the same cross section.

Fig. 4 shows a cross-section of one arrangement for reducing or eliminating the deformation of the curved portion of the beam previously described. During manufacture of the beam, which here has a closed cross section, a preformed support member 40 of synthetic plastics material is placed inside the section. This member 40 operates to hold the faces P of the beam apart and to this end a material having a high modulus of elasticity is chosen. The member is moulded with surface grooves 41 running in the axial direction of the beam so that, after insertion, internal protective fluids can still be passed down the beam to reach all parts of it. Further, axially extending bores 42 are provided and the lateral sides of the member 40 are 'V' shaped at 43 to reduce the weight of the member without unduly affecting its strength. It is not necessary to fasten the member 40 to the internal faces of the beam since once in position at the curves A it will not be possible for it to move into the straight or differently curved portions B (see Fig. 2). As an added measure, however, the member 40 may be made so that it extends slightly into the portions B.

Referring to Fig. 5, if desired, the prop member (here referenced 540) could be made slightly over-size in the direction normal to the propped faces 5P so that under no load conditions of the beam the member 540 is slightly compressed resulting in a light tensioning of the faces 5P. In this way any loss of stiffness of the beam before the support member 40 comes into effect is prevented. Flanges 50 are provided so that the constituent plates of the beam can be clamped together prior to fastening by welding for example.

Alternatively, referring to Fig. 6, the beam can be so constructed that the prop or support member 540 is used as an assembly fixture to load the closing surface (here referenced CP) against the opposite surface prop (referenced OP) thus controlling the shape of the box and ensuring initial contact between prop 540 and plates. Joints between the member providing the closing surface and the remainder of the box are provided along seams A and B by welding or other suitable means.

The invention is also applicable to open section beams (see Fig. 7) except that the prop 740 has to be physically retained between the load bearing surfaces 7P to prevent it falling out. This can readily be done by fastenings 70 on the neutral axis of the beam which would have negligible detrimental effect on the beam strength.

It will be appreciated that the above embodiments have been described by way of example only and that many variations are possible without departing from the scope of the invention. For example, although in the case of the closed box section no fastening between the metal plates of the boxes and the inserted support or prop member are necessary, such fastening members could be provided if desired. In that event (referring to Fig. 9) the support member 940 would generally be formed to accommodate the fastening (referenced 90). Where the

inserted support member extends into the straight portions of the beam, the extensions would, as with the rest of the member, be formed in such a way as to minimise the weight. Thus, for example, these extensions could be provided at their ends with a 'V' shaped relief 80 as shown in Figure 8. The use of a synthetic plastics material support member has particular advantages as fretting and electro chemical reactions between the member and the material of the box section will be avoided. Also, by appropriate moulding, stress concentrations at the terminations of the member can be minimised. Where possible in the drawings the same reference numeral preceded by a digit indicating the Figure number has been used to indicate equivalent features of differing embodiments.

CLAIMS

1. A beam made of sheet material and having a curved portion bounded by surfaces which in use of the beam are load bearing and a support member disposed in the beam at the curved portion but not connected to it along the load bearing surfaces and having a high modulus of elasticity to resist bending of the load bearing surfaces out of the plane of those surfaces when subjected to loads tending to tighten the curvature of the curved portion.

2. A beam as claimed in Claim 1, in which the support member is moulded from synthetic plastics material.

3. A beam as claimed in Claim 2, in which the synthetic plastics material is polypropylene.

4. A beam as claimed in Claim 1, in which the support member is made from metal.

5. A beam as claimed in Claim 4, in which the metal is aluminium.

6. A beam as claimed in Claim 2 or 3, in which the synthetic plastics material is fibre reinforced.

7. A beam as claimed in any preceding Claim, in which the support member is provided with superficial grooves to allow passage of fluid material between it and the internal surfaces of the sheet material.

8. A beam as claimed in any preceding Claim, in which the support member is relieved to reduce its weight.

9. A beam as claimed in any preceding Claim, in which the dimension of the unstrained support member in the direction in which, in operation, it is placed under strain is greater than the corresponding dimension of the beam so that the member is under light strain under no load conditions of the beam.

10. A beam as claimed in any preceding Claim, in which the beam is of closed cross-section.

11. A beam as claimed in any preceding Claim, in which the beam is of open cross-section.

12. A beam as claimed in any preceding Claim, in which the curved portion is bounded in the axial direction of the beam by straight portions, or portions of a substantially different radius of curvature.

13. A beam as claimed in Claim 12, in which the support member extends into the straight portions or substantially differently curved portions.

14. A beam made of sheet material substantially as hereinbefore described with reference to Figures

1 to 4 and 8 or to these figures with the modification of any of Figures 5, 6, 7 or 9 of the accompanying drawings.

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